This gentleman mentions that he has not extended his researches sufficiently to form a definite opinion as to the action of the three systems to which he refers, when the water is highly charged with carbonate of lime. Had he done so he would have found that in this particular case, silicated carbon would have had the advantage of Spencer's magnetic carbide and pure animal charcoal, on account of the presence of the pure silica. However, to reduce hardness of water, I would not entirely rely upon my favourite material, but get the assistance of other agents. Indeed, as I have stated before, an universal filtering medium does not in my opinion exist.

A competent person will not have much difficulty in devising means for an efficient purification of water, and a judicial arrangement will even overcome brackishness to a considerable extent. I have never had much trouble in reducing Thames water impurities to about half a grain of organic matter per gallon with a low degree of hardness.

Messrs. Danks and Co., of Bourke-street will, in a few days, have a model apparatus which has been purposely constructed to suit the Melbourne water supply. It will entirely remove lead and reduce the organic matter to a minimum, without causing flatness. It can easily be attached to the supply-pipes without interfering with the existing arrangements, having also a simple and effective arrangement for the cleansing.

Another apparatus of a portable form will be particularly suitable for country use, at stations, farms, &c.

Art. XXV.—*On a New Self-Registering Electrometer; or, Electrograph.* By R. L. J. Ellery, Esq., President.

[Read 9th December, 1867.]

I have lately erected an instrument at the Observatory for obtaining a continuous record of the amount and variations of atmospheric electricity, the construction of which I believe is in some respects new; I have therefore thought it worth while to lay a description of it before the Society.

I must premise however that the *main principles* of this electrometer are not new, but were devised and applied by Sir W. Thomson, of Glasgow, some years ago, and he described several forms of electrometer involving these principles in the proceedings of the Royal Society of London, "Nicol's Encyclopædia" (1860), and in several other works.

Sir William Thomson has shown in several communications to the Royal Society of London, that if the sensitive or movable portions of any of the ordinary electrometers be kept charged with either positive or negative electricity, it not only becomes highly sensitive to the slightest electric force, but at the same time becomes an electroscopic electrometer, indicating at once whether the impressions made on it are from positive or negative electricity; and his instruments were so constructed that the sensitive movable part or indicator was in connection with the inner coating of a Leyden jar, charged with either positive or negative electricity, the charge being maintained in the jar over long periods without any great change by protecting the jar from external influences by a surrounding metal case, and further by artificially drying the air within the case. The sensitive parts were acted on by insulated pieces of metal, which he styled electrodes, placed in a proper position near to the sensitive parts. The electrode or electrodes were generally arranged so that they could either be placed alternately in connection with the earth or with the body to be tested, or one constantly in connection with the body to be tested, and the other with the earth.

Now, supposing the inner coating of the jar to be charged positively, the sensitive parts are also similarly charged, and would be repelled by any other body *similarly* and attracted by a body *differently* electrified. The surface of the earth is as a rule negative, and if the electrode were connected with the earth, the sensitive part would be attracted; but if the electrode were attached to a positively electrified body, an atmospheric collector for instance, it would be repelled, and this attraction and repulsion would be a joint measure of the amount of electric force on the earth's surface or in the atmospheric collector and the inside coating of the jar; the latter being measurable, the amount of the other forces becomes also measurable.

The mode of conveying to the electrode the electric potential of the atmosphere devised by Sir William Thomson, is very simple and effective; it consists of an insulated vessel of water from which a pipe terminating in a fine nozzle projects into the air; from this nozzle the water issues in a very fine stream soon breaking into drops; the water and vessel rapidly becomes charged with the same potential of electricity as the air at the point where the water breaks into drops. If the vessel be kept indoors, the insulation which it is necessary should be kept perfect, can be more easily maintained. The pipe and nozzle may project through a window or any other opening into the open air. A conducting-wire attached to this vessel gives a means of conveying to the electrode of the electrometer, either periodically or continuously, the electric motive force as possessed by the stratum of air where the water drops from the nozzle.

In the apparatus I have devised, the Leyden jar, metal protecting case and dried air are adopted in the electrometer and the water dropper for the collector, and it is only in the sensititive or movable part that it differs from those hitherto constructed. The sensitive part has always been suspended or held in position by a glass or silk fibre, or metal wire, and the force to be overcome by the electric force to be measured has either been torsion, as in Sir W. Thomson's instrument, or the directive magnetic force of a small magnet, as in Peltar's electrometer; in this instrument, however, the movable part is a delicately poised metronome pendulum; substituting for torsion or magnetism the more measurable and reliable force of gravity. I have styled it "The Pendulum Electrometer," and it may be thus described:

On a heavy base of slate, two upright strong brass stems, about 18 inches long and 10 inches apart, are fixed connected at the top by a stout cross piece of brass; at the centre of this cross piece and at right angles to it, a block of vulcanite is fixed, and to the under part of this again, and also at right angles to the cross piece two segments of a heavy ring of brass of about 4½ inches radius are attached, so that they form together a true circular arch, but with the two segments separated by about one-sixteenth of an inch at the vertex. (Plate) These two segments insulated from all other parts and from one another constitute the electrodes of the apparatus. Between the two pillars a large Leyden jar is fixed to the base, with the mouth upwards. To the inside, bottom and inner coating of this jar a strong brass stem is connected, carrying at its top a brass frame with two arms, reaching above the mouth of the jar, which form the support of the pendulum. The pendulum consists of a light circular ring of brass (to carry a mirror), with two horizontally projecting arms, into which are screwed the two delicate steel cones on which the pendulum is poised; these points are in a line with the centre of the mirror-ring; ninety degrees from these points the top and bottom stems of the pendulum are fixed into the edge of the ring; the upper stem is of light aluminum wire, carrying at its top, about $4\frac{1}{4}$ inches from the centre of the ring, a piece of sheet aluminum about half-inch broad and three inches long, bent to the curve of a circle of $4\frac{1}{4}$ inches radius; this is fixed at right angles to the plane of the mirror frame; the lower stem is a piece of light brass wire screwed over its whole length, on which a small weight to act as a counterpoise can be screwed up and down. On one of the arms of the mirror-frame a stud is fixed, through which is inserted a piece of screwed brass wire to act as a balancing arm. The mirror, which is a circle of silvered parallel glass, is fixed into the ring with cement. The steel suspension-points of the pendulum rest upon flat polished steel surfaces let into the arms of the frame attached to the inner coating of the Leyden jar, and when these surfaces are level, the pendulum properly balanced is counterpoised so as to vibrate once in two seconds; it is then extremely sensitive to the slightest influence. A cradle to lift the pendulum off its bearings and drop it gently and accurately in its place again is adapted to the jar-frame, and is worked by a lifting screw at the back.

The jar and frame is so fixed to the base, that when the pendulum is in its place the small segment of sheet aluminum on its top swings freely and symmetrically under and about one-eighth of an inch distant from the electrode arch. Two leaden trays, holding lumps of pumice stone soaked in sulphuric acid, rest on the slate base, and partially surround the bottom of the jar. Over all this is a cylinder of copper, closed at the top, and fitting on to the base with a ground flange. Through the top of this cylinder there are two tubular apertures, fitted with plugs of vulcanite, through which two stout brass wires are inserted with a sliding air-tight fitting, and pass into holes in the upper surface of the electrodes; one wire ends outside the cylinder in a kind of hook, the other carries a sliding piece, so that it can be brought in metallic communication with the covering cylinder. In front of the cylinder is a window of parallel glass, fitting air-tight. At the back, and on a level with the centre of the mirror is an aperture lined with vulcanite, leaving an opening of about half-an-inch, over which is screwed a close fitting cover; this opening is for admitting the charging rod for charging or discharging the jar. The rod consists of a brass wire terminating at one end in a ball, at the other in a square filed on the wire, the intermediate stem being covered with gutta percha. When the rod is inserted, the square end readily finds its way into a trumpet mouth, formed in the head of the lifting screw, and forms an insulated connection with the inner coating, and at the same time serves as a key for turning the lifting screw for raising or lowering the pendulum. To charge the jar the rod is inserted, and a few good sparks from an electrophorus passed on to the ball end; the rod is then carefully withdrawn and the opening closed; the air within being dried by the sulphuric acid, and the jar and sensitive pendulum protected from all external electrical influence by the covering cylinder; the charge of the jar remains sufficiently constant over a considerable period.

The pendulum need never be lifted off its bearings except to adjust it, or in case it has got out of position, when the lifting and lowering it puts it into its place again.—The pendulum being adjusted, and the jar charged, the former is highly sensitive to electrical influences presented to it through the electrodes; and if we now connect one electrode with the earth by slipping down the sliding piece (S) till it touches the cover, the pendulum is immediately moved towards the earth electrode if the jar is charged positively, and *vice versa* if negatively. The mirror moving with the pendulum gives a means of ascertaining the amount of its deviation from the vertical or zero position; to this end a scale is set up in front of the window and mirror, so that its reflected image can be seen—this image is viewed by the aid of a telescope, as the mirror moves the scale appears to move, and a different position is seen in the telescope.

Suppose before the jar is charged the scale reading corresponding to the zero position of the pendulum is m—this is the zero reading, after charging and connecting earth electrode $m + n$, this is called the earth reading. The difference between the two readings, or n, is a measure of the charge of the jar, and varies with it; and as the stronger the charge the more sensitive the pendulum, a correction to the indications due to a change in charge is always necessary and afforded by n.

If now a wire from the water dropper is connected to the hook wire or *air electrode*, the pendulum will be acted on by the electric force of the air where the water drops, and if the jar is positive, will be attracted towards this electrode when the air is negative, and repelled when it is positive, in proportion to the electric potential. And as the pendulum is so made that the deflections are seldom large, its angular deviation may be taken as proportional to the force.

I have arranged this Electrometer so as to be continuously self-registering by photography, on the same principle as is adopted at Kew for the magnetographs, a full description of which arrangement is given in the British Association reports for 1859.

This apparatus may be therefore styled "The Pendulum Magnetograph." The method of procedure adopted is this: The electrometer being adjusted and charged, and the water cistern (which is made to contain twenty-four hours supply) filled and dropping, the revolving cylinder covered with sensitive paper, and the clock going; at about 9 a.m., the earth electrode is connected, but the other disconnected, it is left thus for five or six minutes, and the scale reading obtained and entered as the *earth reading*; at the end of this time the water dropper is connected to the earth electrode, it is left so till 9 a.m. next day, when the cistern is disconnected and filled, the light shifted so as to get the second day's curve and the earth reading, and left on five or six minutes, then the cistern is connected. At 9 a.m. next day the same process is gone through, with the addition of removing the sensitive sheet from the cylinder and putting on a fresh one.

The sheets when photographicively finished by developing and fixing, shows curves corresponding to the variation of electric potential, and both the time and extent of these can at once be obtained from them. The beginning and end of each day's curve is marked by a short mark, distinct and somewhat removed from the general curve; this is the earth reading at the beginning and end of each day and is the photographic registration of the pendulum's position when the earth electrode only was connected; a line drawn from one to the other may be assumed as the line of earth readings for the twenty-four hours, and forms the datum line from which the ordinates to the curves are measured. If we wish to tabulate the numerical values of the ordinates from these curves a correction has to be applied to each ordinate, depending on the distance of this datum from the zero line, or line that would be made by the reflected dot when the pendulum was vertical. I submit a few of the curves for your inspection, and hope, at some future time, to bring before you some results obtained by this apparatus, and describe the manner in which the indications obtained are converted to absolute measure in adopted units of force.

Art. XXVI.—*Experiments on Mr. Julius Dahlke's Filter.*

By Mr. J. Cosmo Newbery.

[Read 9th December, 1867.]

At the last meeting of this Society a paper was read by Dr. Neild for Mr. Julius Dahlke, describing a new filter, which was stated to be peculiarly adapted for filtering water containing organic matter, and water which, having passed through lead pipes or vessels, contained salts of lead. And the statement that it would remove acetate of lead, and some other salts from solution without chemical action was so remarkable, and of so much importance, that I gladly undertook to try some experiments with the filter and report the results to you. I am very much pleased to be able to corroborate all Mr. Dahlke's statements, and indeed go further. Upon receiving the filter I poured into it solutions of sulphate of magnesia and common salt, and to my astonishment found only traces of these salts in the filtrate, so small that they could only be detected chemically. These salts were followed by strong acetic and hydrochloric acids, with like results, the water from each being absolutely tasteless. I finally added strong yellow sulphide of ammonium, which passed through as pure water. Upon inverting the filter and pouring in hot water, the sulphide of ammonium was discharged undecomposed, showing that though it fol-